Hearing Loss Prevention (Noise)

Resources

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Eliminating Noise

Use with Chapter 296-817 WAC, Hearing Loss Prevention (Noise)

How can noise be eliminated from the workplace?

When noise monitoring results indicate that workers are exposed to harmful noise levels, the best way to protect them is to eliminate the noise exposure versus using personal protective equipment. Using personal protective equipment can have many drawbacks and will not always be effective. Even small flaws in the fitting or use of hearing protection will significantly reduce its effectiveness. Sound can also be transmitted directly into the inner ear through the skull and have other effects on the body, so there are limits to the effectiveness of hearing protection. Small flaws in fitting or using an earplug or earmuff may not be apparent until a year or two after an employee starts using it, when follow-up testing is conducted. By that time irreparable hearing loss may have occurred.

Eliminating Noise at the Source

Quieting the noise source directly will often be the most efficient way to reduce exposures. Most industrial noise is not part of the work, it is due to machinery operation or materials being worked on or handled. Often, small changes in equipment or processes can significantly reduce noise with little change in the efficiency or effectiveness of the work site. There are a variety of ways to reduce noises at the source:

- Install mufflers on engines.
- Use silencers wherever gases are being released, particularly on the exhausts from compressed air actuated equipment.
- Be sure equipment is in good operating condition—no squeaking parts, no rattling parts, etc.
- Be sure equipment is operating as designed—compressed air pressures are set at manufactures recommended levels, motion is within design limits and not hitting stops or other objects, impact pressure is set correctly.
- Use the correct equipment for the work—inefficient equipment may generate more noise and will usually generate noise for a longer time.
- Damp noise producing machine panels and materials. Some panels and materials will work like drums or bells to produce noise when they are shaken, vibrated or struck. Damping means to hold the materials tightly to prevent them from continuing to vibrate or adding materials that absorb the vibration energy.
- Move workstations further from noise sources.

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In most cases, noise in the workplace is a sign of inefficiency—energy is being used to make noise rather than the products to be sold. The amount of energy necessary to create a harmful exposure is not great, but may be a sign of other inefficiencies in the system. Working to eliminate noise will often have benefits in improved efficiency and more effective production. A program to regularly monitor noise levels in the workplace will not only prevent over-exposure of employees, but may have added benefits such as identifying maintenance or adjustment problems with equipment and improving plant efficiency.

Noise Enclosures and Barriers

Where noise cannot be eliminated at the source, the next form of noise control is to use engineering controls to intercept the sound as it travels from the noise source to the workers. The most effective way to do this is to create a closed box either around the equipment or the worker. Enclosing the sound source should also include adding acoustic insulation to absorb the sound being generated to make the enclosure as effective as possible. Special care must be taken to make sure materials can enter the enclosure and that cooling air and other equipment needs are accounted for without excessive openings into the enclosure. Using entry tunnels and baffles can allow full access to the machinery without compromising the effectiveness of the enclosure.

Barriers

Barriers may be simple walls or curtains of acoustic materials. Barriers have limited effectiveness unless they are very near either the noise source or the employee to be protected. Otherwise, the sound tends to simply travel around the barrier. Placing a barrier around a particularly noisy work area may limit the noise exposure of other workers, but will typically not reduce the exposure of workers performing the operation.

Acoustical panels or baffles

Acoustical panels or baffles are commonly installed near particularly noisy machinery, either on walls or ceilings. These can effectively cut down reflected noise, but do not address the direct noise exposure, which is usually much more significant. These panels and baffles are best suited as additions or treatments of enclosures or barriers.

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Eliminating Noise

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Buy Quiet Programs

The engineering controls discussed above are often much more cost effective when they are planned and purchased with the equipment. Typically, the equipment will be fitted for the control system, or the controls will be installed during manufacture. This also eliminates the costs of studying and designing the noise controls. By considering noise during planning and purchasing of equipment, it is also possible to take advantage of plant layout and design to minimize noise problems. For example, if a particular machine will be the primary noise source in the plant, the production floor may be arranged to make it simpler to isolate that machine.

Administrative Controls

Another strategy to controlling noise exposures is to use administrative controls, in other words, to change work practices to minimize exposures. In some cases, simply scheduling work appropriately or moving workstations away from high noise areas can result in a significant reduction in noise exposure. Where specific tasks or machinery are the primary noise exposure for employees not working directly with those tasks, moving these employees to other locations may eliminate their noise exposure with little effect on the processes involved. Where employees must move from one location to another, paths should be provided allowing them to avoid high noise areas.

Hearing Protection - Additional Information

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The most convenient method to use when evaluating the type of hearing protection needed is the noise reduction rating (NRR) developed by the Environmental Protection Agency (EPA). According to the EPA regulation, the NRR must be shown on the hearing protector package. The NRR is then related to an individual worker's noise environment in order to assess the adequacy of the attenuation of a given hearing protector. The NRR was developed for use in evaluating hearing protection from environmental sources measured with C-weighting.

The following methods must be used to calculate protected occupational exposure using A-weighted data as required under this rule:

- In general, it is best to fit hearing protection with a protected exposure sufficiently below the PEL to provide a safety factor. However, excessive protection, where the protected exposure is below about 70 dBA may interfere with communication and the employee's ability to hear activity or alarms around them.

  Examples:

  – Hearing protection example: 90 dBA exposure using earplugs with an NRR of 20 dB. The effective protection for the plugs is 13 dB and the protected exposure is 77 dBA, which is below the PEL.

  – Dual hearing protection example: 105 dBA exposure using earplugs with an NRR of 33 dB and earmuff with a NRR of 29 dB. The effective protection is 31 dB and the protected exposure is 74 dB, which is below the PEL.

Instead of using the NRR, employers may evaluate the adequacy of hearing protector attenuation by using one of the three methods developed by the National Institute for Occupational Safety and Health (NIOSH), which are described in the List of Personal Hearing Protectors and Attenuation Data, HEW Publication No. 76-120, 1975, pages 21-37. These methods are known as NIOSH Methods No. 1, No. 2 and No. 3. The NRR described here is a simplification of NIOSH Method No. 2. The most complex method is NIOSH Method No. 1, which is probably the most accurate method since it uses the largest amount of spectral information from the individual employee's noise environment.

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Hearing Protection - Additional Information

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As in the case of the NRR method described, if one of the NIOSH methods is used, the selected method must be applied to an individual's noise environment to assess the adequacy of the attenuation. Employers should be careful to take a sufficient number of measurements in order to achieve a representative sample for each time segment.

The employer must remember that calculated attenuation values reflect realistic values only to the extent that the protectors are properly fitted and worn.

More information on NRR:

- The 7 dB reduction is based on the typical difference between industrial noise as measured using A-weighting and the noise used in the laboratory to measure attenuation when the hearing protector is evaluated for determination of the NRR.
- If a value other than 7 dB would appear appropriate, the employer should use one of the alternate evaluation methods rather than using the NRR method.
- Similarly, the estimated NRR for dual hearing protection is based on typical results for such systems. Where a NRR specific to the dual protection system worn is available or other data allows use of the alternate evaluation methods, the employer may choose to do so.

Noise Computation Examples

Use with Chapter 296-817 WAC, Hearing Loss Prevention (Noise)

This helpful tool gives you examples of noise computations that should assist you with your own computations. Also found in this helpful tool are examples of employer actions based on the specific noise computation results. You'll need to do your own noise computations and determine the specific actions needed based on the noise exposures in your workplace.

EXAMPLE 1

Assume an employee is exposed to 92 dBA for eight hours. Compute the employee's noise exposure, the time-weighted average and what action, if any, would be required of the employer.

Exposure:

The exposure time is 8 hours. The reference duration for 92 dBA is 6 hours.

$$D = 100 \times \left(\frac{C_1}{T_1} \right) = 100 \times \left(\frac{8}{6} \right) = 133\%$$

Time-weighted Average (TWA):

In **Table HT-2**, find the values for 130% and 135%. The difference in the time-weighted average values (92.2 - 91.6) equals 0.6. Since 133% is 3/5 of the way between 130 and 135, 133% equals 3/5 (0.6) + 91.6 = 92 dBA.

Employer Action:

Since the employee's exposure is above the 90 dBA TWA_8, the employer would be required to institute a full hearing loss prevention program, including:

- Controlling noise as feasible,
- Providing hearing protection and training for employees,

  AND
- Instituting an audiometric testing program.

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Noise Computation Examples

Use with Chapter 296-817 WAC, Hearing Loss Prevention (Noise)

EXAMPLE 2

Assume a continuous noise exposure for an employee of 90 dBA and a work shift of 8 a.m. to 4: 30 p.m. with a 15-minute morning and afternoon break and a 30-minute lunch. Both breaks and lunch are in an area with less than 70 dBA exposure. (Although this exposure could be integrated into the employee's total noise exposure, it is not significant and will not be considered in these calculations.) Calculate the worker's exposure, TWA, and the employer's responsibility.

Exposure:

Actual exposure (subtracting the lunch time and work breaks from the employee's work shift) indicates a 90 dBA exposure for 7-½ hours. D = 100 (C_1/T_1) = 100 (7.5/8) = 94 (94%)

$$D = 100 \times \left(\frac{C_1}{T_1}\right) = 100 \times \left(\frac{7.5}{8}\right) = 94\%$$

Time-weighted Average (TWA):

From **Table HT-2** a noise exposure of 94% converts to an equivalent 8-hour time-weighted average of 89.6 dBA.

Employer Action:

Since the employee's time-weighted average is between 85 and 90 dBA TWA_8, a hearing loss prevention program must be developed and maintained for the employee including hearing protection, training and audiometric testing. Engineering and/or administrative controls are not required, but may be beneficial, since the hearing loss prevention program would no longer be required if the employee's exposure were reduced below 85 dBA TWA_8.

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Noise Computation Examples

EXAMPLE 3

Assume a technician works in a noise enclosure booth with a noise exposure of less than 70 dBA. The technician makes rounds to read gauges and instruments that are located in an area with a noise level of 105 dBA. The technician makes four trips a day, and each trip lasts 30 minutes. Calculate the employee's noise exposure, TWA and employer's responsibility.

Exposure:

With four trips a day and 30 minutes per trip, the employee is basically exposed to two hours of noise at 105 dBA with the remaining time spent inside the booth. From **Table HT-1** of the rule the reference duration for exposure at 105 dBA is 1 hour.

$$D = 100 \times \left(\frac{C_1}{T_1}\right) = 100 \times \left(\frac{2}{1}\right) = 200\%$$

Time-weighted Average:

The employee's TWA from **Table HT- 2** is 95 dBA.

Employer Action:

Since the employee's exposure is above the 90 dBA TWA_8, the employer would be required to institute a full hearing loss prevention program, including controlling noise as feasible, providing hearing protection and training for employees, and instituting an audiometric testing program.

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Noise Computation Examples

Use with Chapter 296-817 WAC, Hearing Loss Prevention (Noise)

EXAMPLE 4

Assume a timber trimsaw operator with a background noise level inside the operator's booth of 85 Dba, cuts one timber every 10 seconds with a noise exposure during the cut of 105 Dba for three seconds. The employee works from 6 a.m. to 4:30 p.m. and has a 15-minute break in the morning and the afternoon and a 30-minute lunch break, all of which are below 70 Dba. Calculate the employee's noise exposure and TWA.

Exposure:

First sound level - 105 dBA

The employee is exposed to this sound level for three seconds out of every ten or 30% of the time. Thus the time of exposure (C_1) at this level is 0.3×9.5 or 2.85 hours. From **Table HT- 1**, the reference duration (T_1) is one hour.

Second sound level - 85 dBA

The employee is exposed to this sound level for seven seconds out of every ten or 70% of the time. Thus the time of exposure (C_2) at this level is 0.7×9.5 or 6.65 hours. From **Table HT-1**, the reference duration (T_2) is sixteen hours.

$$D = 100 \times \left(\frac{C_1}{T_1} + \frac{C_2}{T_2} \right) = 100 \times \left(\frac{2.85}{1} + \frac{6.65}{16} \right) = 327\%$$

Time-weighted Average (TWA):

From the conversion table we find a noise dose of 327% lies between 320 and 330 with values of 98.4 dBA and 98.6 dBA respectively.

320% = 98.4 dBA

330% = 98.6 dBA

327% = (7/10)*(0.2) + 98.4 = 98.5

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Noise Computation Examples

Use with Chapter 296-817 WAC, Hearing Loss Prevention (Noise)

EXAMPLE 5

Assume a security guard works an eight-hour shift and makes eight rounds a night. In making a round of the facility the guard will spend 20 minutes in Building A, 30 minutes in Building B and 10 minutes in the yard. In Building A the noise levels are less than 70 dBA. Noise level in the yard is 85 dBA. In Building B there is a cyclic machine operation where the noise levels are:

- 100 dBA for 3 seconds (30%)
- 95 dBA for 3 seconds (30%), and
- 90 dBA for 4 seconds (40%)

Calculating the employee's noise exposure and time-weighted average (TWA):

Since the employee's noise exposure in Building A is less than 70 dBA, this exposure is not significant and will not enter into the computation (the theoretical dose would be less than 2%). In Building B we find three noise exposures, 100, 95, and 90 dBA respectively. The yard also has an exposure (85 dBA), which will enter into the total computation.

Calculating the partial exposures at each noise level we find:

At 100 dBA

$$30\% \times \frac{30\text{ minutes}}{\text{round}} \times \frac{8\text{ rounds}}{\text{shift}} \times \frac{\text{hour}}{60\text{ minutes}} = \frac{1.2\text{ hours}}{\text{shift}}$$

At 95 dBA

$$30\% \times \frac{30\text{ minutes}}{\text{round}} \times \frac{8\text{ rounds}}{\text{shift}} \times \frac{\text{hour}}{60\text{ minutes}} = \frac{1.2\text{ hours}}{\text{shift}}$$

At 90 dBA

$$40\% \times \frac{30\text{ minutes}}{\text{round}} \times \frac{8\text{ rounds}}{\text{shift}} \times \frac{\text{hour}}{60\text{ minutes}} = \frac{1.6\text{ hours}}{\text{shift}}$$

The yard at 85 dBA

$$\frac{10\text{ minutes}}{\text{round}} \times \frac{8\text{ rounds}}{\text{shift}} \times \frac{\text{hour}}{60\text{ minutes}} = \frac{1.33\text{ hours}}{\text{shift}}$$

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Noise Computation Examples

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EXAMPLE 5 (continued)

The employee's total noise exposure can be calculated from the noise exposure formula using the following values.

Location	Sound Level	Time of Exposure	Reference Duration
Building B	100 dBA	C_1 = 1.2 hours	T_1 = 2 hours
Building B	95 dBA	C_2 = 1.2 hours	T_2 = 4 hours
Building B	90 dBA	C_3 = 1.6 hours	T_3 = 8 hours
Yard	85 dBA	C_4 = 1.33 hours	T_4 = 16 hours

The employee's total noise exposure (D) is computed as follows:

$$D = 100 \times \left(\frac{C_1}{T_1} + \frac{C_2}{T_2} + \ldots + \frac{C_n}{T_n} \right) = 100 \times \left(\frac{1.2}{2} + \frac{1.2}{4} + \frac{1.6}{8} + \frac{1.33}{16} \right) = 118\%$$

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Noise Computation Examples

Use with Chapter 296-817 WAC, Hearing Loss Prevention (Noise)

Table HT-1

Reference Durations, in Hours, for given Noise Levels

Noise Level, L	Reference Duration, T
80	32.0
81	27.9
82	24.3
83	21.1
84	18.4
85	16.0
86	13.9
87	12.1
88	10.6
89	9.2
90	8.0
91	7.0
92	6.1
93	5.3
94	4.6
95	4.0
96	3.5
97	3.0
98	2.6
99	2.3
100	2.0
101	1.7
102	1.5
103	1.3
104	1.1
105	1.0
106	0.87
107	0.76
108	0.66
109	0.57
110	0.50
111	0.44
112	0.38
113	0.33
114	0.29
115	0.25
116	0.22
117	0.19
118	0.16
119	0.14
120	0.13
121	0.11
122	0.095
123	0.082
124	0.072
125	0.063
126	0.054
127	0.047
128	0.041
129	0.036
130	0.031
131	0.027

Noise Computation Examples

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Table HT-2

Dose to Equivalent TWA_8 for Given Dose

Dose	TWA_8
10	<=70
20	78.4
30	81.3
40	83.4
50	85.0
60	86.3
70	87.4
80	88.4
90	89.2
100	90.0
110	90.7
120	91.3
130	91.9
140	92.4
150	92.9
160	93.4
170	93.8
180	94.2
190	94.6
200	95.0
210	95.4
220	95.7
230	96.0
240	96.3
250	96.6
260	96.9
270	97.2
280	97.4
290	97.7
300	97.9
310	98.2
320	98.4
330	98.6
340	98.8

Dose	TWA_8
350	99.0
360	99.2
370	99.4
380	99.6
390	99.8
400	100.0
410	100.2
420	100.4
430	100.5
440	100.7
450	100.8
460	101.0
470	101.2
480	101.3
490	101.5
500	101.6
510	101.8
520	101.9
530	102.0
540	102.2
550	102.3
560	102.4
570	102.6
580	102.7
590	102.8
600	102.9
610	103.0
620	103.2
630	103.3
640	103.4
650	103.5
660	103.6
670	103.7
680	103.8

Dose	TWA_8
670	103.7
680	103.8
690	103.9
700	104.0
710	104.1
720	104.2
730	104.3
740	104.4
750	104.5
760	104.6
770	104.7
780	104.8
790	104.9
800	105.0
810	105.1
820	105.2
830	105.3
840	105.4
850	105.4
860	105.5
870	105.6
880	105.7
890	105.8
900	105.8
910	105.9
920	106.0
930	106.1
940	106.2
950	106.2
960	106.3
970	106.4
980	106.5
990	106.5
1000	106.6

Noise Computation Examples

Use with Chapter 296-817 WAC, Hearing Loss Prevention (Noise)

Resources

SUMMARY

As you can see, the more variable the noise sources or exposure times, the more involved the computations become. Noise dosimeters overcome this problem by electronically accumulating and integrating the noise signals into the employee's noise dose. Having one person observe several noise dosimeters can save additional time. However, a simultaneous survey using a sound level meter must be conducted to support the dosimeter results.